3.3.1 FOS Load Catalog

All valid loads that are available for uplink are maintained in the FOS Load Catalog. For each load in the Load Catalog, the FOS maintains four files in the Load Catalog: the load contents from which the load was generated, the load in uplink format, the load generation report, and the load image that may be compared against a memory dump image. The Load Catalog also maintains identifying information about the load. The list of valid loads in the Load Catalog may be viewed on the Catalog Search Window, shown in Figure 3.3.1-1. Loads to be included in the list may be selected based on load type, owner, and time of uplink.

Figure 3.3.1-1. Catalog Search

3.3.2 Building RTS Load Contents

The IST allows the user to create and edit Relative Time Sequence (RTS) load contents using the RTS Builder, shown in Figure 3.3.2-1. An RTS load content is a series of command mnemonics, usually having associated time tags expressed as time relative to the previous command in the sequence. All mnemonics in an RTS must be defined in the PDB. The times associated with the commands will be checked against the command timing constraints defined in the PDB.

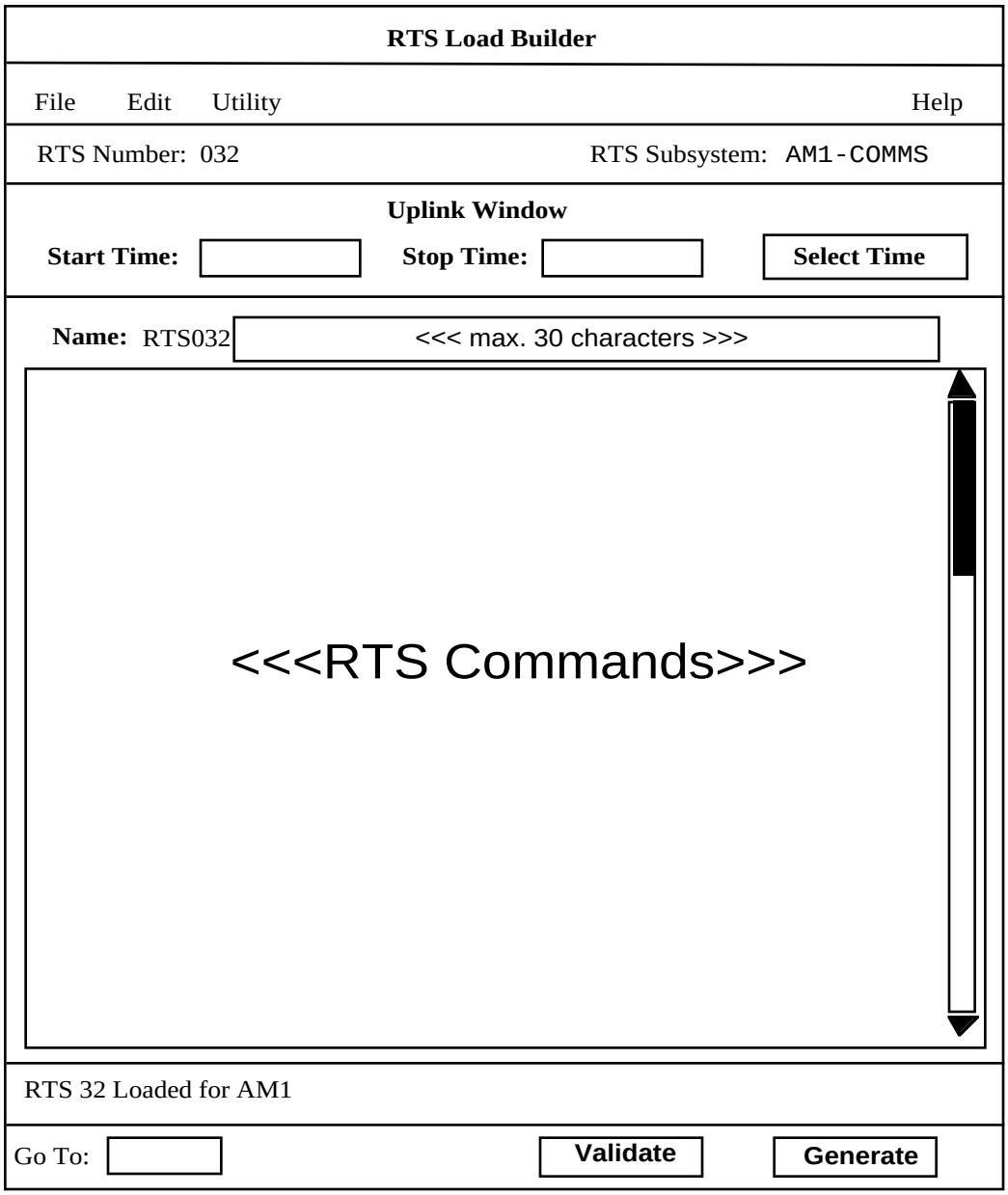

Figure 3.3.2-1. RTS Load Builder Window

The RTS Load Builder includes a menu bar with four pull-down menus: **File**, **Edit**, **Utility**, and **Help**. Just below the menu bar is an identification line. This line contains the sequence number of the RTS load and its associated subsystem or instrument (e.g., AM1-COMMS). The user may modify the subsystem field, if appropriate. Underneath the identification line is a pair of time fields. These fields allow a user to define the uplink window for the RTS load. The times may be entered manually, or the user may access the time selector to specify the times. Underneath the time fields is a text field where the user may specify the function or purpose of

the table load (e.g., PATCH03). The text in this field is appended to the label 'RTSxxx', where 'xxx' is the RTS number, to form the name of the RTS load. A scrolling text window, located below this text field, contains the RTS load contents (i.e., directives and relative time offsets) entered by the user. Standard keyboard and mouse editing functions (e.g., Page Up, Page Down, highlighting with the mouse, etc.) are accommodated in this window. Under the text window is a status line The status line displays messages indicating the completion of user-activated operations (e.g., RTS load generated). If an error occurs during an operation, the status message will provide information to assist the user in resolving the error. Along the bottom of the RTS Load Builder window is a text input field that allows a user to enter a line number for the Go To operation. Next to the Go To text field are two buttons that allow the user to validate the load contents or to generate the binary load.

The RTS Load Builder provides the user with standard editing capabilities through a combination of keyboard and mouse input. The keyboard is used primarily to enter the RTS load contents, to modify the associated subsystem/instrument identifier, and to enter the load function. Support for keyboard control keys (e.g., Page Up, Page Down, Home, End, etc.) is also provided. Accelerator keys are provided for both the menu bar and the pull-down menu options (e.g., <alt>F displays the File menu).

The mouse is used to position the cursor within the RTS load contents, to perform standard Motif selection operations (e.g., double-click selects the current word, triple-click select the current line, quadruple-click select all text), to select options from the menu bar and pull-down menus, and to select the **Validate** or **Generate** buttons. The RTS Load Builder menu bar contains four pull-down menus: File, Edit, Utility, and Help. The File menu options include:

New	opens a template file that is used to create a new RTS load contents file.
Open	displays a file selection dialog window that allows the user to open an existing RTS load contents file. An existing file can be used to create a new RTS load.
Save	saves the current RTS load contents file. This option should be used in cases where the user wants to save the results of the current edit session without generating a load.
Print	displays a file selection dialog window that allows the user to print a selected RTS load contents file (default is the current RTS load contents file).
Quit	exits the RTS Load Builder.

The Edit menu contains the options that allow the user to perform typical cut, copy, paste, find, and replace operations. The Edit menu options include:

Undo	performs an undo of the last edit operation.
Cut	deletes the selected text and places it into the clipboard.
Copy	places a copy of the selected text into the clipboard.
Paste	inserts the text in the clipboard into the procedure text at the current cursor location

Delete	deletes the selected text.
Find	activates a find dialog that allows the user to either find and highlight the next occurrence of a specified text string or to highlight all occurrences of the text string.
Replace	activates a replace dialog that allows the user to either find the next occurrence of a one text string and replace it with another specified string or to replace all occurrences of a text string.

The Utility menu provides access to the Command Builder, which may be used as an aid in constructing RTS commands. At this time the Utility menu includes only one option:

Command Builder	activates/deactivates the Command Builder

The user may specify the start and stop times for the valid uplink period by either manually entering these times in two text fields or by accessing the Time Selector utility. The Time Selector is accessed via a pushbutton, **Select Time**, located to the right of the start and stop time fields. The Time Selector updates the start and stop time text fields when the user closes this window.

The RTS Load Builder outputs includes status messages, a warning dialog, an informational dialog, saved RTS load contents files, and updated RTS load contents information. Status messages indicate the completion status of user-specified operations, including:

- opening (reading) a RTS load contents file,
- saving (writing) a RTS load contents file,
- printing a RTS load contents file,
- validating the load contents,
- generating the binary load file,
- searching for text (number of occurrences found), and
- replacing text (number of replacements performed).

A warning dialog is displayed when a user attempts to create a new RTS load contents file, open an existing RTS load contents file, or exit the RTS Load Builder if modifications have been made to the current RTS load contents since the last save or generate operation. The warning dialog provides options to save the current contents file, discard the load contents modifications, or cancel the current action (e.g., cancel the quit operation).

An informational dialog is displayed whenever validation or load generation errors are detected. This dialog contains the error messages, including the offending directive text, if appropriate.

The RTS load contents file and RTS load contents information are saved as the result of a save operation. The status of these operations is displayed to the user via one of the status message described above.

3.3.3 Building Table Load Contents

The IST allows the user to create and edit table load contents using the Table Builder, shown in Figure 3.3.3-1. A table load contents file may be built for any table that is defined in the PDB. A table load contents file may be built using default values in the PDB, a previously generated table load contents file, and/or user input.

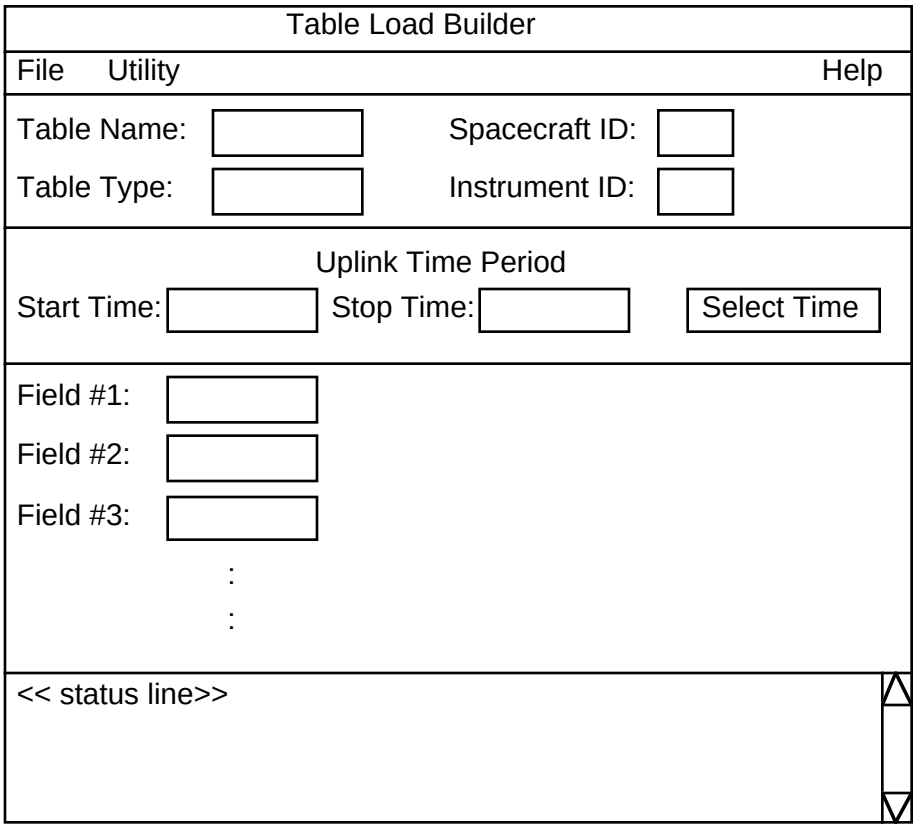

Figure 3.3.3-1. Table Load Builder

The Table Load Builder includes a menu bar with three pull-down menus: File, Utility, and Help. Just below the menu bar is an identification area. This area contains the table name, table type, spacecraft ID, and instrument ID. The uplink time period area is below the identification area. It allows user to define the uplink start and stop times. A scrollable text widget locate at the bottom of the window represents the status messages area. Status messages indicating the completing of user-activated operations (e.g., Table Load Generated) are displayed in this area. If an error occurs during an operation, the status message will provide information to assist the user in resolving the error.

The Table Load Builder provides the user with standard editing capabilities through a combination of keyboard and mouse input. The keyboard is used primarily to enter or modify

the table name, spacecraft, and instrument identifiers. The mouse is used to perform standard Motif selection operations, and to select options from the menu bar and pull-down menus.

The Table Load Builder contains three pull-down menus: File, Utility, and Help. The File menu options include:

New...	displays a selection dialog window. It allows a user to select a table template.
Open Table...	displays a selection dialog window. It allows a user to select table parameters from existing table load contents.
Open Dump...	displays a selection dialog window. It allows a user to select table parameters from table load dumps.
Save	allows user to save the current table parameters.
Quit	exits the Table Load Builder.

The Utility menu contains the options that allow the user to perform special operations. The Utility menu options include:

Validate	validates the table parameters for each field of the table template. It will generate a message on the status line indicating whether the validation process is successful or not.
Generate	will automatically validates the table parameters and sends a load generation request to CMS. CMS creates a new table load if no errors are detected.

The Uplink Time Period area allows a user to specify a valid uplink start and stop times. The Select Time button will display a time selector window to allow for the selection of times by orbit and orbital event. The Start Time and Stop Time fields allow user to specify the starting time and stopping time for uplink.

The Table Load Builder will update metadata and table load contents. The Table Load Builder outputs includes status messages. Status messages are displayed at the status line area. Status messages indicate the generic status of user-specified operations. Error message(s) will appear in the status area if user has entered invalid table parameter(s). Field(s) in error will be highlighted.

3.3.4 Transferring Load Contents to FOS

Load contents files that are created externally to the FOS may be imported to the FOS at the IST via the Load Ingest window. Load contents that may be created externally to the FOS include microprocessor loads and RTS loads or table loads that are not created with the FOS RTS or Table Builder tools. Microprocessor loads are generated in binary form by the SCF. Microprocessor load formats are discussed in Appendix B. RTS loads would ordinarily be generated using the FOS RTS Builder, but any RTS load contents file that is in mnemonic form may be imported to the FOS via the Load Ingest window. Table loads would ordinarily be generated using the FOS Table Builder, but a table load contents file that is in the format defined in the Table PDB may be imported to the FOS via the Load Ingest window.

The Load Ingest window, shown in Figure 3.3.4-1, allows the user to select a load contents file in the user's non-FOS (SCF) directory. When the user clicks on the OK button, the file whose name appears in the Selection box will be transferred to an FOS directory. Once the file is in and FOS directory, it may be accessed from the Load Manager window.

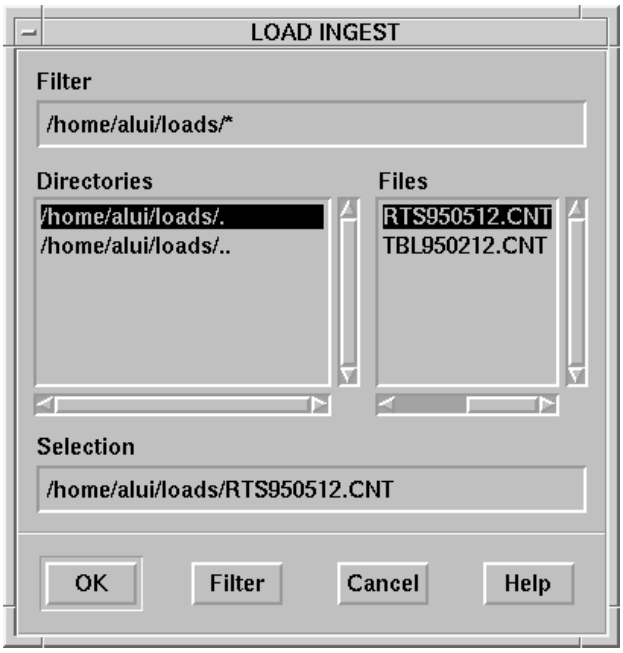

Figure 3.3.4-1. Load Ingest

3.3.5 Generating Loads in Uplink Format

Load contents files must be converted to uplink format and entered into the FOS Load Catalog to be made available for uplink. This process is called load generation. The IST allows the user to request the generation of loads from load contents via the Load Generator window, shown in Figure 3.3.5-1. The Load Generator window allows the user to specify the destination, offset, size, and valid uplink period for the load. When the user clicks on the OK button, the load contents will be converted to uplink form and the load will be entered in the Load Catalog.

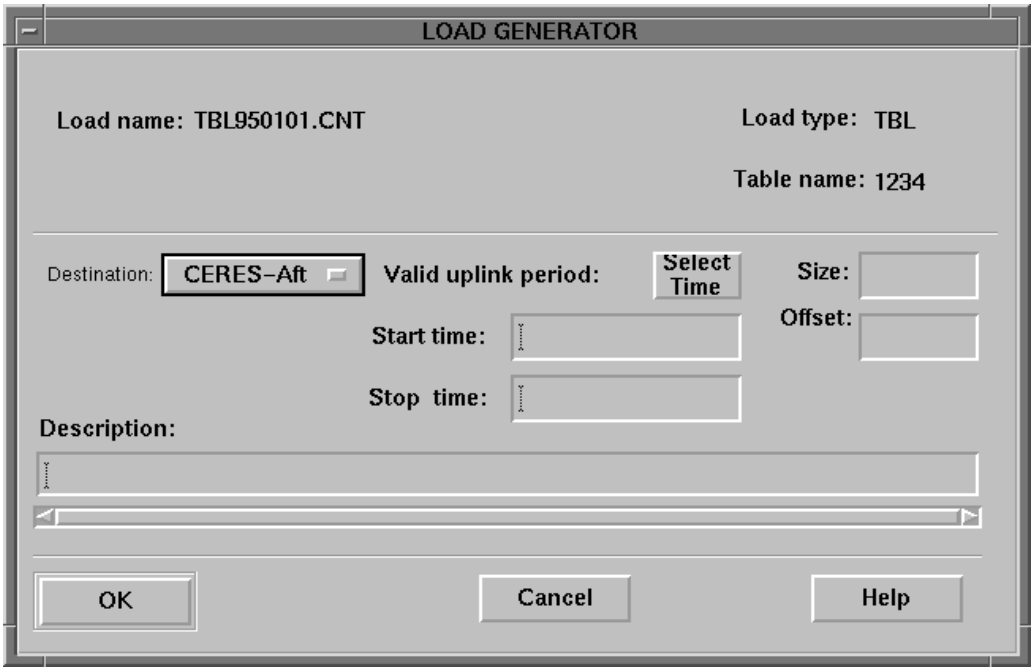

Figure 3.3.5-1. Load Generator

3.3.6 Requesting Uplink of Loads

The Load Scheduler Tool provides the IOTs and FOT with the capability to schedule the uplink times for the various spacecraft and instrument loads, including instrument microprocessor loads, flight software loads, table loads and RTS loads. The user-specified time period corresponds to an uplink window (e.g. a 6 hour time period) that the FOT/IOTs desire their load to be sent. The Load Scheduler Tool will use this time window to select three valid communication contacts to uplink the specified load, the first being designated the prime contact, while the remaining two are backups. If three valid communication contacts are found, the user will be notified of the chosen communication contacts through their timeline display and status messages. During generation of the ground script, the command procedures for uplinking the load will be inserted into the ground script for execution by the FOT.

The Load Scheduler Tool is launched by the Load Manager Tool. The Load Manager Tool provides the Load Scheduler Tool with the name of the load the user desires to schedule. Figure 3.3.6-1 shows the display for the Load Scheduler Tool.

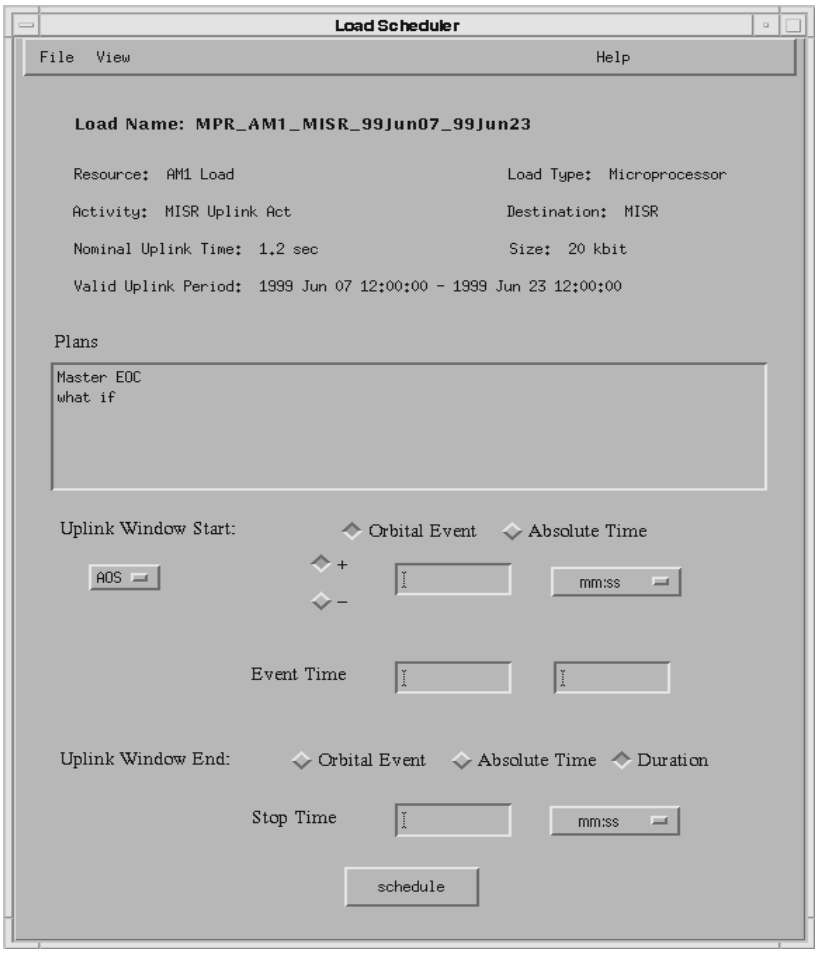

Figure 3.3.6-1. Load Scheduler Tool Display

3.3.7 FOS Memory Dump Processing

Memory dump telemetry that has been received in the EOC is available to the IST as a memory dump image file containing the dump telemetry without the CCSDS and EDOS headers. The user may request a dump comparison, a dump report, or the export of the dump file to the SCF.

The dump comparison is requested via the ECL line in the control window. FOS software will compare the dump file to a load file and issue a summary event message. The user may request a comparison report listing the discrepancies or the entire image in hex with the discrepancies flagged.

The dump file may be exported from the FOS to the SCF using the Data Mover tool.

3.3.8 Viewing CMS Reports

Command Management generates a report whenever a load (ATC, RTS, table, microprocessor, or flight software) is generated from a load content. These load reports include the load generation time, uplink window, scheduled uplink time, load size, and load ownership. An integrated report is generated whenever a ground script is generated (nominally once per day). The integrated report includes information on all loads to be uplinked and stored commands expected to execute during the period. All CMS reports are accessible from the IST.

3.3.8.1 ATC Load Reports

The ATC load contains the absolute time commands that will execute from the stored command table onboard the spacecraft. The load is generated by the FOT in the EOC, nominally once per day. The load is based on the Detailed Activity Schedule which is built by Planning and Scheduling.

The CMS generates an ATC Load Report whenever an ATC load is generated. An ATC Load Report may be accessed from the Periodic Report Selector Dialog. The ATC Load Report includes the following information:

Load name

Load type

Valid uplink period - Time range during which this load may be uplinked

Scheduled time - Specific time at which this load is scheduled for uplink

Uplinked date and time - Time at which load was successfully uplinked (applies only to loads that have been uplinked)

Load size in bytes

Starting and ending ATC buffer locations - locations into which the first and last commands of the load will be mapped in the stored command table

Execution times of the first and last commands

Number of commands

Number of critical commands

Load initiate command - includes CRC value

A listing of all absolute time commands in the load, including for each command:

1. the command's memory location in the stored command table
2. execution time
3. command mnemonic
4. submnemonics and their values, if applicable
5. command bit pattern
6. criticality indicator

3.3.8.2 RTS Load Reports

The CMS generates an RTS Load Report whenever an RTS load is generated. An RTS Load Report may be accessed from the Periodic Report Selector Dialog. The RTS Load Report includes the following information:

Load name

Load type

Valid uplink period - Time range during which this load may be uplinked

Scheduled time - Specific time at which this load is scheduled for uplink

Uplinked date and time - Time at which load was successfully uplinked (applies only to loads that have been uplinked)

Load size in bytes

RTS buffer number

Starting and ending memory locations in the RTS table

Number of commands

Number of critical commands

A listing of all RTS commands in the load, including for each command in the load:

1. the command's memory location
2. offset time, if applicable
3. command mnemonic
4. submnemonics and their values, if applicable
5. command bit pattern
6. criticality indicator

3.3.8.3 Table Load Reports

The CMS generates a Table Load Report whenever a table load is generated. A Table Load Report may be accessed from the Periodic Report Selector Dialog. The Table Load Report includes the following information:

Load name

Load type

Valid uplink period - Time range during which this load may be uplinked

Scheduled time - Specific time at which this load is scheduled for uplink

Uplinked date and time - Time at which load was successfully uplinked (applies only to loads that have been uplinked)

Load size in bytes

Starting and ending memory location

Contents of each field of the table

3.3.8.4 Microprocessor Load Reports

The CMS generates a Microprocessor Load Report whenever a microprocessor load is generated. A Microprocessor Load Report may be accessed from the Periodic Report Selector Dialog. The Microprocessor Load Report includes the following information:

Load name

Load type

Valid uplink period - Time range during which this load may be uplinked

Scheduled time - Specific time at which this load is scheduled for uplink

Uplinked date and time - Time at which load was successfully uplinked (applies only to loads that have been uplinked)

Load size in bytes

Starting and ending memory location

Contents of the load in hex

3.3.8.5 Integrated Report

The CMS generates an Integrated Report whenever a Detailed Activity Schedule is received from Planning and Scheduling. An Integrated Report may be accessed from the Periodic Report Selector Dialog. The Integrated Report includes the following information:

Absolute time commands to be executed

Relative time commands to be executed

Scheduled spacecraft contacts

Real-time commands to be uplinked

Loads to be uplinked

Expected orbital events

3.4 Monitor Telemetry

3.4.1 Monitoring Real-Time Telemetry

The IST allows a user to monitor spacecraft and instrument housekeeping and instrument engineering telemetry that is being received and processed in real-time at the EOC. Additionally, the IST allows a user to monitor simulations and historical telemetry replays that are currently being processed at the EOC. (Historical telemetry includes both real-time and spacecraft recorder telemetry.) The IST allows a user to display telemetry data from one or more instrument and/or one or more spacecraft simultaneously.

The IST user begins by selecting telemetry displays to view. Displays will nominally default to a current real-time logical string (more about strings later). Telemetry display types include alphanumerics, graphs, tables and schematics. Figures 3.4.1-1 through 3.4.1-5 depict different telemetry displays. Note that all display types can be combined in a single display as in Figure 3.4.1-4.

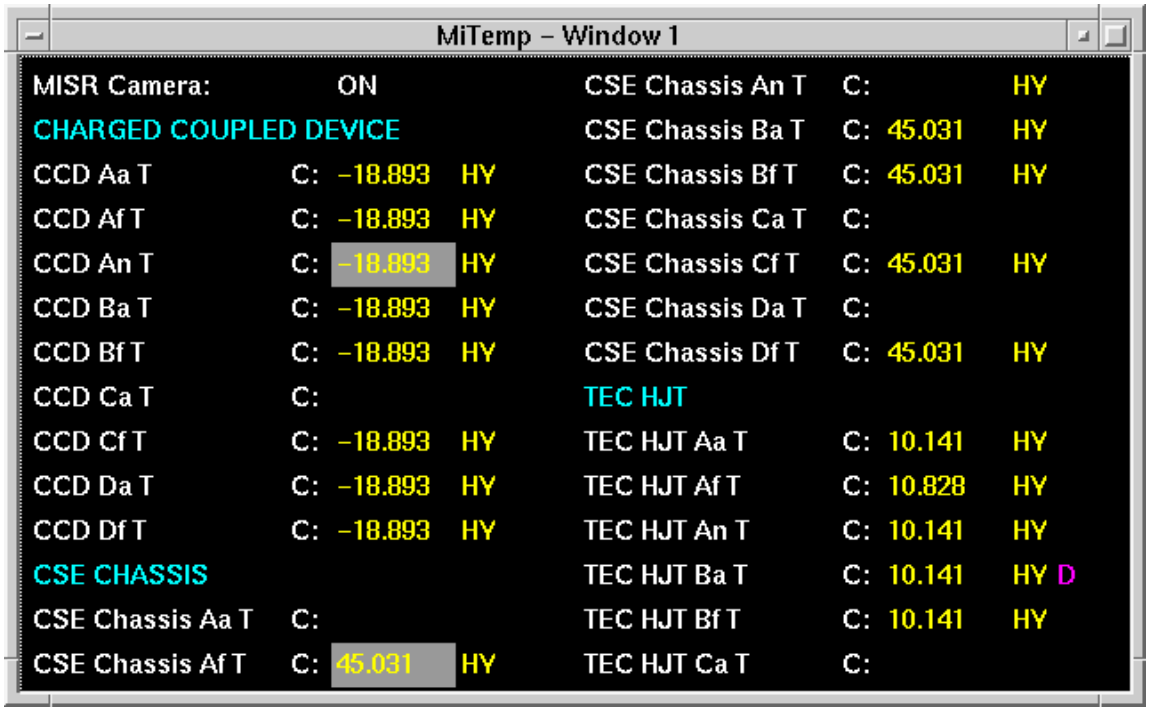

Figure 3.4.1-1. Sample Alphanumeric Telemetry Display

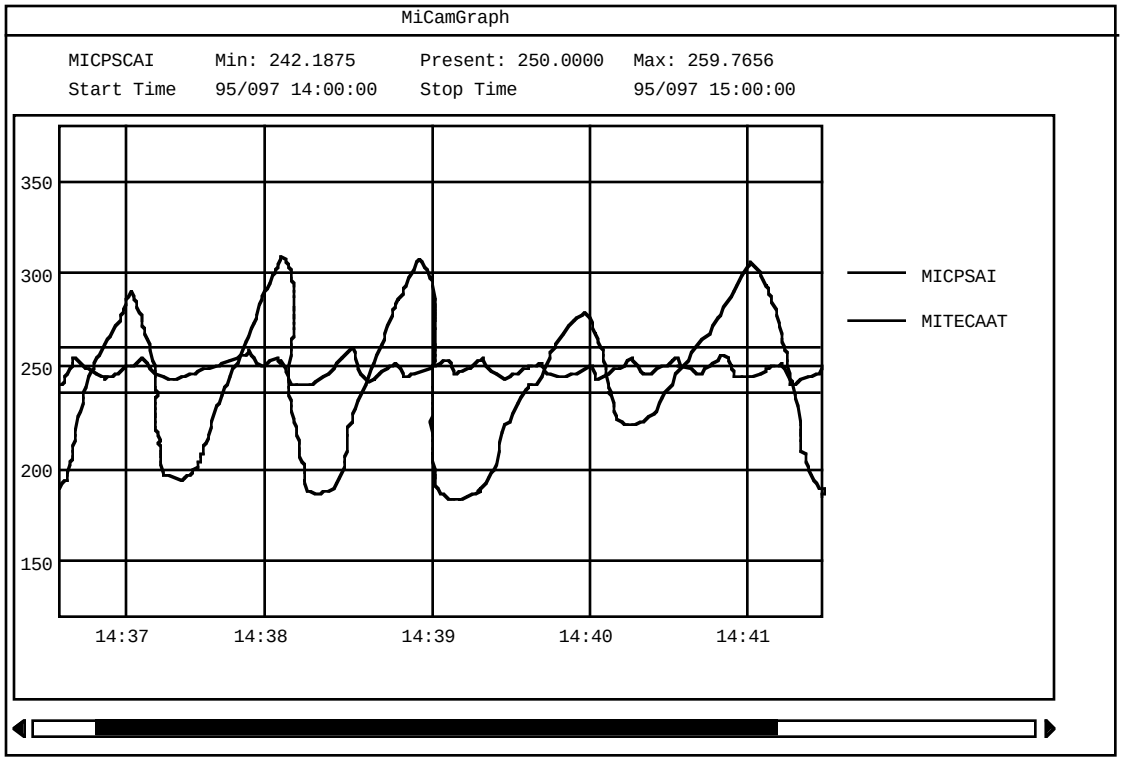

Figure 3.4.1-2. Sample Graph Telemetry Displays

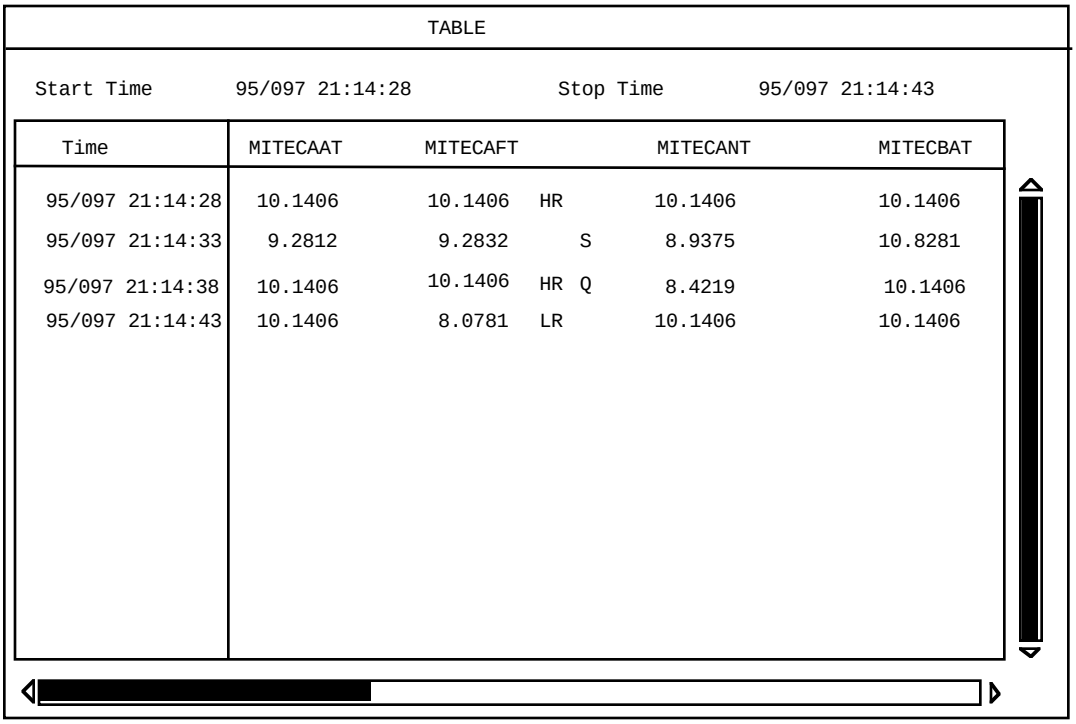

Figure 3.4.1-3. Sample Table Telemetry Display

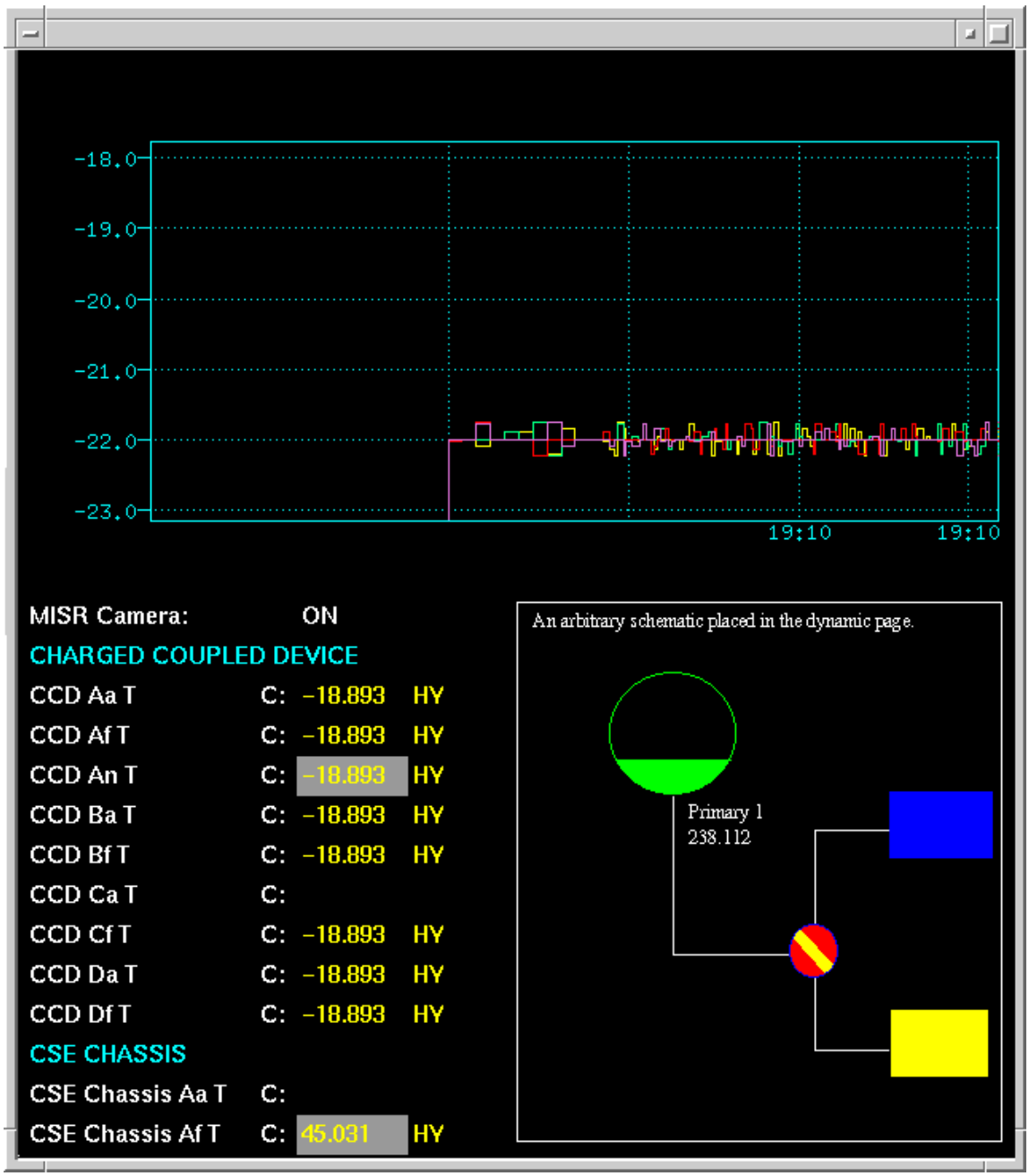

Figure 3.4.1-4. Sample Combined Telemetry Display

The IST user may select the real-time telemetry sources (or sources) for display from the set of real-time telemetry sources currently being processed at the EOC. A telemetry source is monitored through what is termed a logical string.

A logical string is a collection of hardware and software resources, and information about how these resources are being used to provide spacecraft and instrument control and monitoring during real-time contacts, simulations, and historical replays. A unique logical string exists for each real-time scenario (i.e., contact, simulation, and historical replay). There are five attributes of a logical string that make it unique. These attributes include:

- a spacecraft identifier which marks a logical string for support of a specific mission
- a operational database identifier which indicates the database version used in configuration of the software in a specific logical string
- the data source which indicates the origin of the telemetry data being monitored within the logical string (i.e., real-time, simulation, historical replay)
- the mode attribute which indicates the intended use of the logical string (i.e., operational, test, training)
- and the state attribute which indicates if a logical string in the operational mode is actively performing its intended function (active), or if it exists only to perform its intended function in the event of a hardware or software failure in the active string (backup)

The IST user may select multiple real-time telemetry sources to be displayed simultaneously by requesting connection to multiple logical strings. Limitations in the number of simultaneous real-time logical string connections will be based on bandwidth allocation between the EOC and the IST. Information related to real-time sources the user has selected will be visible to the IST user via a status window. The status window contains information such as UTC, spacecraft time, count down clock, current orbit number, telemetry mode, packet sequence count, etc.

An group of IST users wishing to monitor the same historical telemetry replay will request that the Flight Operations Team allocate resources on a Real-Time Server within the EOC to perform the replay and allow multiple users from different IST workstations to simultaneously monitor the replay. Resources permitting, an operator within the EOC will create what is called a shared replay logical string. (When resources within the EOC are allocated to provide a shared service such as this, all EOC and IST users have visibility into this activity. In other words, any other user interested in this activity can connect to the established logical string and monitor the activity.) The IST users interested in the newly created replay logical string are then provided information regarding the newly created logical string and given an opportunity to connect to that string from a service request window. Upon connection, all interested parties are able to simultaneously view the requested replay.

Users of the EOC can also request dedicated services or dedicated logical strings. Examples of dedicated logical strings include dedicated historical replays and offline analysis requests. In these instances, a user would simply request the dedicated service, and resources that reside only on that user's workstation would be employed to provide the requested service. Other users would not have visibility into, or knowledge of that user's activities, nor would other users be able to connect to, or otherwise access that activity. In other words, the activity is dedicated to a single IST user. In this scenario, full replay control would be given to the IST user via the replay control window. Historical replays are controlled by the Replay Controller tool depicted in Figure 3.4.1-5.

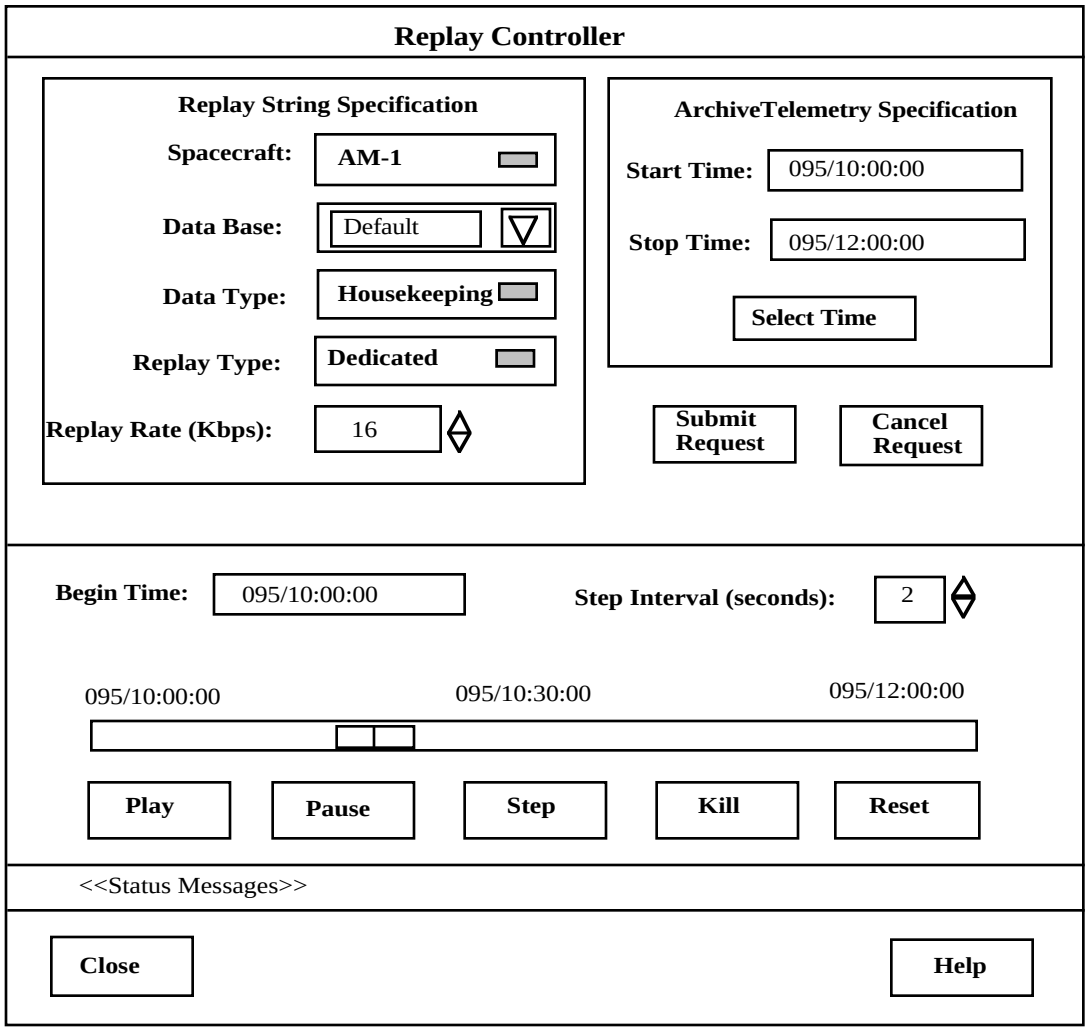

Figure 3.4.1-5. Replay Controller

The Replay Controller window is divided into two major sections. The top section is used to define the replay request. The bottom section is used to control the replay once the resources (i.e., the logical string components) required for the replay have been allocated.

The top section of the Replay Controller window allows the user to specify the parameters for a replay request. The Replay String Specification area allows the user to specify parameters using a combination of option menus and text fields. These parameters include:

- Spacecraft (option menu) - default value is AM-1. This option menu will contain the spacecraft identifier of all operational vehicles.
- Data Base (combo box) - default value is the operational data base corresponding to the specified telemetry data. A user may enter the identifier of an alternate data base that will be used to decom the telemetry. If the default value is used, data base crossovers will be handled automatically. If a specific data base identifier is provided, the replay decom process will use the specified data base regardless of any data base crossovers.

- Data Type (option menu) - default value is Housekeeping; other options include Health&Safety and Standby.
- Replay Type (option menu) - default value is Dedicated. A user with ground control authority may specify a shared replay. If a shared replay is specified, the option will also include the identifier of the Real-Time Server (1-3).
- Replay Rate (text field) - default value is 16 Kbps for Housekeeping and 1 Kbps for Health&Safety and Standby. The user may enter a number from 1 to 150 (AM-1 specific) for the replay rate. Two arrow buttons located next to the text field may be used to increment or decrement this value.

The Archive Telemetry Specification area is used to define the time frame of the data to be replayed. The user may type in the start and stop time in the respective text fields, or activate the Time Selector, via the Select Time button, to specify these values. The Time Selector is further defined in Section 3.9.7.

Once the Replay String Specification and Archive Telemetry Specification information has been entered, the user must select the Submit Request button to initiate processing of the replay request. If the required replay resources are available, the corresponding logical string(s) is created. A status message, indicating the success or failure of the replay request, will be displayed on the status line located near the bottom of the window. If successful, the top section of the Replay Controller is deactivated (i.e., becomes insensitive) since changes to the replay configuration are not allowed, and the control functions of the window are activated. If the required replay resources are not available, the request is placed in a queue and a Pending status message is displayed. The replay request will be processed as soon as the required resources become available. The user may cancel a pending replay request by selecting the Cancel Request button.

The bottom section of the Replay Controller window provides the mechanism to control the replay. The control features of this window allow the user to pause and resume the replay, as well as to step through the replay at a user-specified interval.

A Begin Time text field allows the user to specify a new start time for the replay. This new start time must be a time between the start and stop times specified in the Archive Telemetry Specification area when the logical string was created. The Begin Time field defaults to the original start time and may only be modified when the replay is paused.

A Step Interval text field allows the user to select the interval, in seconds, that will be used to step through the replay. When paused, the replay will advance by the value of this field each time the Step button is pressed.

A slider bar shows the user the current time of the replay with respect to the initial start and stop times. The slide bar advances when the replay is active. When paused, the user may adjust the slider bar to select a new begin time (i.e., modifies the Begin Time text field).

Five buttons are located just beneath the slider bar. The Play button is used to start the replay when it is paused, and the Pause button is used to suspend an active replay. The Step button advances the replay by the specified Step Interval. The Kill button terminates the replay and

allows the user to specify new replay parameters. When the Kill button is selected, the user is prompted with a confirmation dialog, which provides the option to cancel or continue the termination request. The Reset button moves the slider bar back to the last specified Begin Time. The Step and Reset buttons are active only when the replay is paused.

Two buttons are located along the bottom of the Replay Controller window. The Close button will remove the Replay Controller window, terminating the replay. The user is prompted with a warning dialog, which allows the user to cancel or continue the close action. The Help button activates a window that provides help information about the Replay Controller.

The output of the Replay Controller consists of status messages displayed on the status line located above the Close and Help buttons. These status messages provide feedback for user actions, such as the success or failure of a replay request and the occurrence of data base crossovers.

The logical string created as a result of using the replay controller will be reflected in the Data Source Selector. The Data Source Selector allows a user to connect dynamic pages to a logical string. Multiple logical strings will be created if data base crossovers occur (one additional logical string per crossover). If a data base crossover is detected, the replay will automatically pause to allow the user to manually switch the logical string assignment of any dynamic pages associated with the replay.

The use of the control functions (e.g., pause a replay) will be reflected in the telemetry data that is displayed on any connected dynamic pages.

When a logical string exists on a Real-Time Server it is shareable by definition. When an IST user connects to a logical string, that user is provided a set of telemetry processes to execute on his local workstation, equal in number to those that are executing within the selected logical string on the Real-Time Server within the EOC. A user must decide at connect time if he wants to control the ground configuration of the processes that are running on his local workstation or simply take the ground configuration and of the processes running on the Real-Time Server. To make this selection, the user must connect to the logical string in one of two ways: by mirrored connection or by tailored connection. These connection methods are described in the paragraphs that follow.

When a user requests a mirrored connection to a logical string, that user is provided the same telemetry ground configuration as the telemetry processes running on the Real-Time Server. Changes to the ground configuration on the Real-Time Server can only be made by a single user per logical string with the Ground Control Privilege. (Ground Control Privilege is reserved for use by EOC personnel only. Ground Control Privilege, much like Command Authority, is requested by EOC users and granted to EOC users that are pre-authorized by the Flight Operations Team to have this privilege for the mission supported in a given logical string.) After a mirrored user connects to a logical string, all subsequent changes to the ground configuration of the logical string are made to the telemetry processes on the user's local workstation as well. Thus, the ground configurations of the telemetry processes on the Real-Time Server and those that execute on the User Workstation are synchronized. A benefit of the mirrored connection, for users within the EOC, is that the user of this connection is eligible to request Ground Control

Privilege for the logical string to which he is connected. If this user is pre-authorized for that privilege, he can potentially control the ground configuration of the telemetry processes that execute on the Real-Time Server for this logical string. It is not required, however, that the mirrored user serve in this capacity. Mirrored logical string connections will be the nominal connection type of choice among EOC users.

When a user requests a tailored connection to a logical string, that user is initially provided the same telemetry ground configuration as the telemetry processes running on the Real-Time Server. Upon connection however, the tailored user controls the ground configuration for the telemetry processes created on his local workstation independent of any privilege. Changes made by this user affect his local processes only. Further, this user is not eligible to gain the Ground Control Privilege that would allow him to modify the ground configuration of the telemetry processes running on the Real-Time Server for this particular logical string. Tailored logical string connection will be the nominal connection type of choice among IST users.

3.4.2 Telemetry Analysis

The IST provides the user the capability to perform analysis of historical telemetry that is archived at the EOC or the Distributed Active Archive Center (DAAC). (Historical telemetry includes both real-time and spacecraft recorder telemetry.) Access to historical data is through the analysis tools that allow the static viewing of history data (see section 3.5), or through the replay of history data (see the replay controller in section 3.4.1). The IST provides the capability for the user to monitor a dedicated replay. A dedicated replay refers to a replay of historical telemetry at the IST which is available to a single IST user. For a dedicated replay, the IST user can select a time range and rate for the replay. The user specified replay rate can be up to 150 kilobits per second. The IST user can also pause and resume the replay. (Dedicated replay is explained in detail in section 3.4.1)

The IST user can send a message to the EOC requesting that a shared replay be set-up within the EOC. A shared replay is available to multiple users, including IST users, simultaneously. An IST user many not directly set up a shared replay. (Shared replay is explained in detail in section 3.4.1)

User's have two tools to create output views of telemetry, the display builder (see section 3.9.4) and Quick Analysis. The Quick Analysis window is used by the user to create display pages of real-time data based upon the selection of telemetry parameters. The display pages provide updating displays of real-time telemetry data in several output views. The Quick Analysis window provides a selection filter to allow easy selections of spacecraft subsystems and telemetry parameters and a format option for customizing output views.

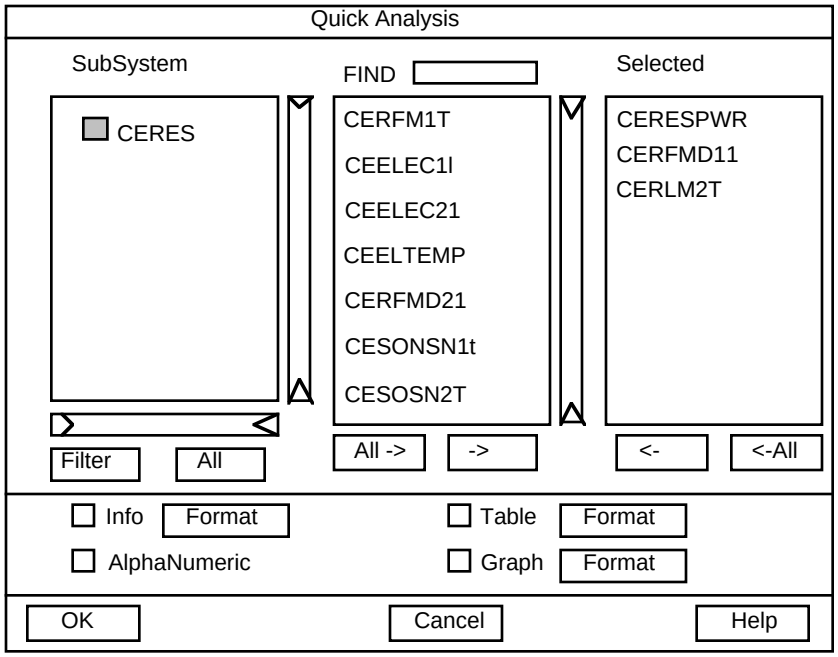

Figure 3.4.2-1. Quick Analysis Window

The Quick Analysis window can be accessed from the Control Window or from a graph and table display page. If the Quick Analysis window is accessed from a graph or table display page, all selected parameters, by default , will be displayed as selected parameters in the Quick Analysis window. If accessed from the Control Window, available subsystems will be displayed for selection.

3.5 Analysis

From an IST, a user can do analysis on instrument and spacecraft engineering data which is maintained in the ECS archive for the life of the mission. During a contact, real-time telemetry values can be viewed on telemetry display pages or on a real time graph. Telemetry display pages consist of telemetry parameters along with descriptions arranged in a user defined format. This format is saved after the page is created, and the display page may be accessed immediately for future real-time viewing. More in-depth performance and trending analysis can be performed on historical data.

The IST user can do any or all of the following types of analysis on historical data:

- Data Filtering (Capture every Nth sample, or changes only)
- Statistics on specified interval (Min, Mean, Max, Standard Deviation)
- User Defined Algorithms (C or C++ functions linked dynamically at run time)

- View System Statistics (System Generated statistics can be graphed or put into a table. System generated statistics are statistics generated automatically at the EOC for all telemetry parameters. These statistics are generated on daily, monthly, orbital, and mission-to-date time spans)

Results of the analysis can be displayed in plots or tables. Data within plots can be manipulated by zooming, smoothing, curve fitting, and Fourier transforms. Plots can be modified to use various colors and symbols, and can be printed.

Requests for analysis, known as Analysis Requests, can contain any combination of the above, and can be saved and edited. The time span of the Analysis Request can be anything from 1 second to the mission life span, although extremely long requests of a week or more may run into problems with system resources such as memory and disk space. This allows the user to define analysis to be done on a periodic basis. this analysis will automatically be initiated by the IST using the user specified time interval, such a daily, weekly, or monthly.

3.5.1 System and User Statistics

System Statistics are automatically calculated by the system for each telemetry parameter in the ODB. These are computed over several intervals such as daily, monthly, orbital, and mission to-date. The type of statistics computed depends on the type of parameter being processed:

Analog Parameter:	Minimum, Maximum, Mean, Standard Deviation for the interval.
Discrete Parameter	Number of state changes, Time spent in each state for the interval.
All Parameters	Type, Start Time, and duration of each limit violation.

In addition to the statistics that are automatically computed, the user may define criteria for generating MMM values and standard deviations. User-defined statistics can be calculated over a time interval greater than or equal to one second and less than or equal to one day.

3.5.2 User Algorithms

The user may create algorithms written in the C or C++ language and add these algorithms to the analysis system. Each algorithm can have a number of inputs and outputs, depending in the author's need. The algorithm is added to the analysis system via a registration process, and should be thoroughly tested before registration is performed.

The algorithm feature allow complex calculations to be incorporated into routine analysis throughout the mission lifetime. Figure 3.5-1 shows the Algorithm Registration Window.

Once the algorithm is registered successfully, it may be used within the Analysis subsystem by adding it into an Analysis Request. In the analysis request, the user must map each input symbol in the algorithm with a telemetry parameter, and must provide a name for each output symbol in the algorithm. This will allow a single algorithm to be used on several different groups of parameters. An example would be an algorithm that does a calculation of battery information that is applied to all three batteries by mapping parameters from each battery to the same algorithm.

For each algorithm, the user must select a timing mechanism which drives the invocation of the algorithm. There are two possibilities:

1. The algorithm is called every N seconds.
2. The algorithm is invoked every Nth occurrence of a specified key parameter.

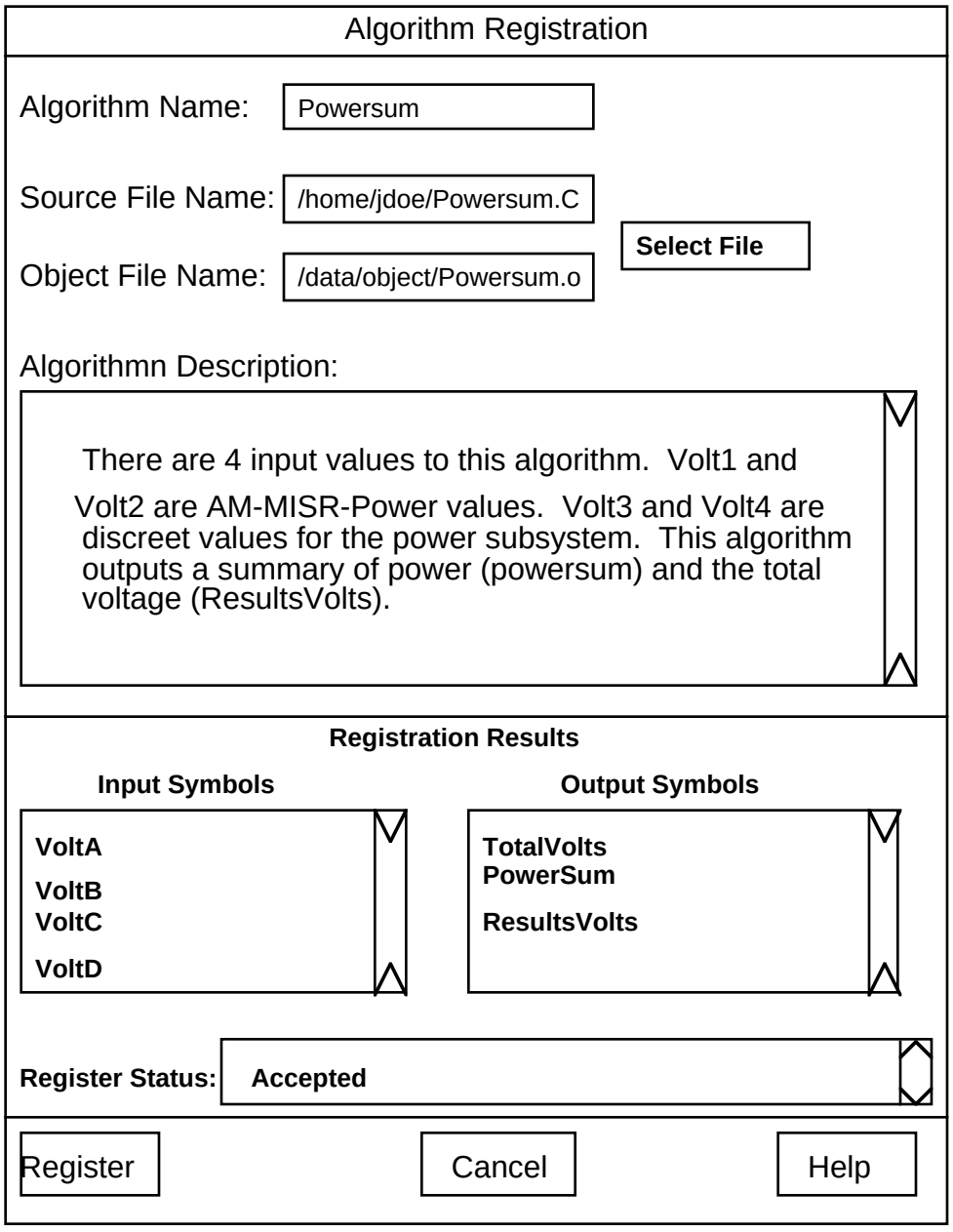

Figure 3.5-1. Algorithm Registration Window

3.5.3 Using Analysis Tools

To initiate analysis, the IST user brings up the analysis request builder (see figure 3.5-2) and builds a request by choosing a list of one or more mnemonics. Spacecraft and instrument housekeeping telemetry, including derived telemetry parameters, may be selected. The user may choose to see the raw values or the Engineering Unit (EU) converted values. A sampling rate for each parameter may be specified, or changes only may be requested.

Next, the user may select parameters for statistical reduction using Min, Max, Mean, and Standard Deviation. Each parameter can have a different user defined statistics interval from 1 second to 24 hours.

Next, User Algorithms are chosen, and telemetry parameters are mapped to each algorithm variable using the algorithm selector window. Each algorithm will have a method of invocation selected. This method can be either every N seconds, or every Nth occurrence of a specified key parameter. For example, and algorithm could be chosen and invocation could be defined to occur every 5th occurrence of "ParameterX". "ParameterX" does not need to be a parameter that is used in the algorithm. Note that this selection is made at the Analysis Request level, therefore algorithm timing can be adjusted without modifying the algorithm itself. See figure 3.5-3.

Finally, a contiguous interval of time must be defined by specifying spacecraft times for the request start and finish. Once the description of the Analysis Request is complete, the IST user can choose from a variety of output formats, including graphs, spreadsheets, Carry-Out files and reports.

Carry-Out files are ASCII file formatted data files, containing analysis results, that can be ingested by IOT COTS spreadsheet packages. The Carry-Out format is defined in Appendix A.

The system will provide some predefined report formats, such as a Parameter Out-of-Limits Report that will list the time and duration of limits violations for each mnemonic specified in the request. A user-defined report can also be created. A user-defined report could be a simple listing of mnemonics and values or it could include several different graphs and text. How the data is presented in a report is called a report template. The user can define a report template and then request the data to apply to it. Once a request for analysis is submitted, the IST will give the user status information to determine if it is in the queue, currently processing, or completed. The request can be saved and accessed again for further analysis.

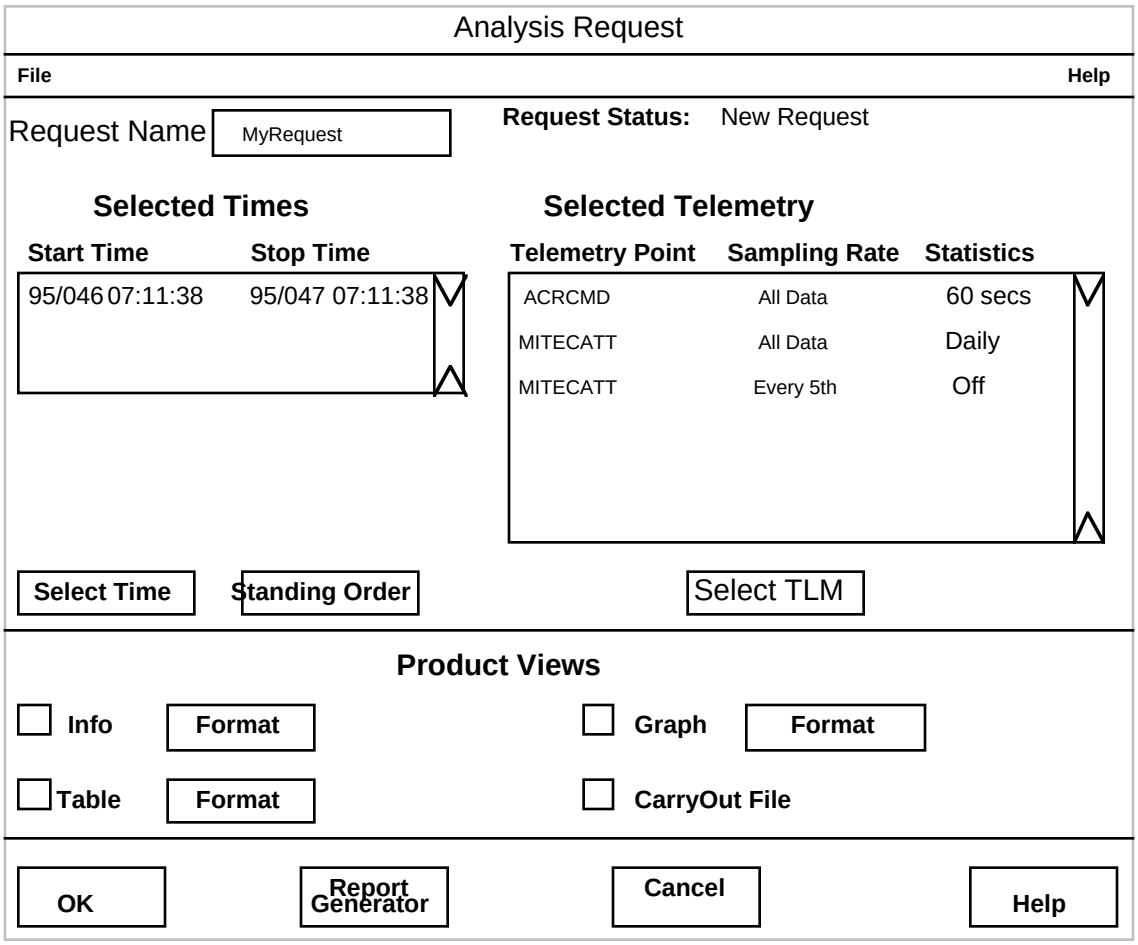

Figure 3.5-2. Analysis Request Builder

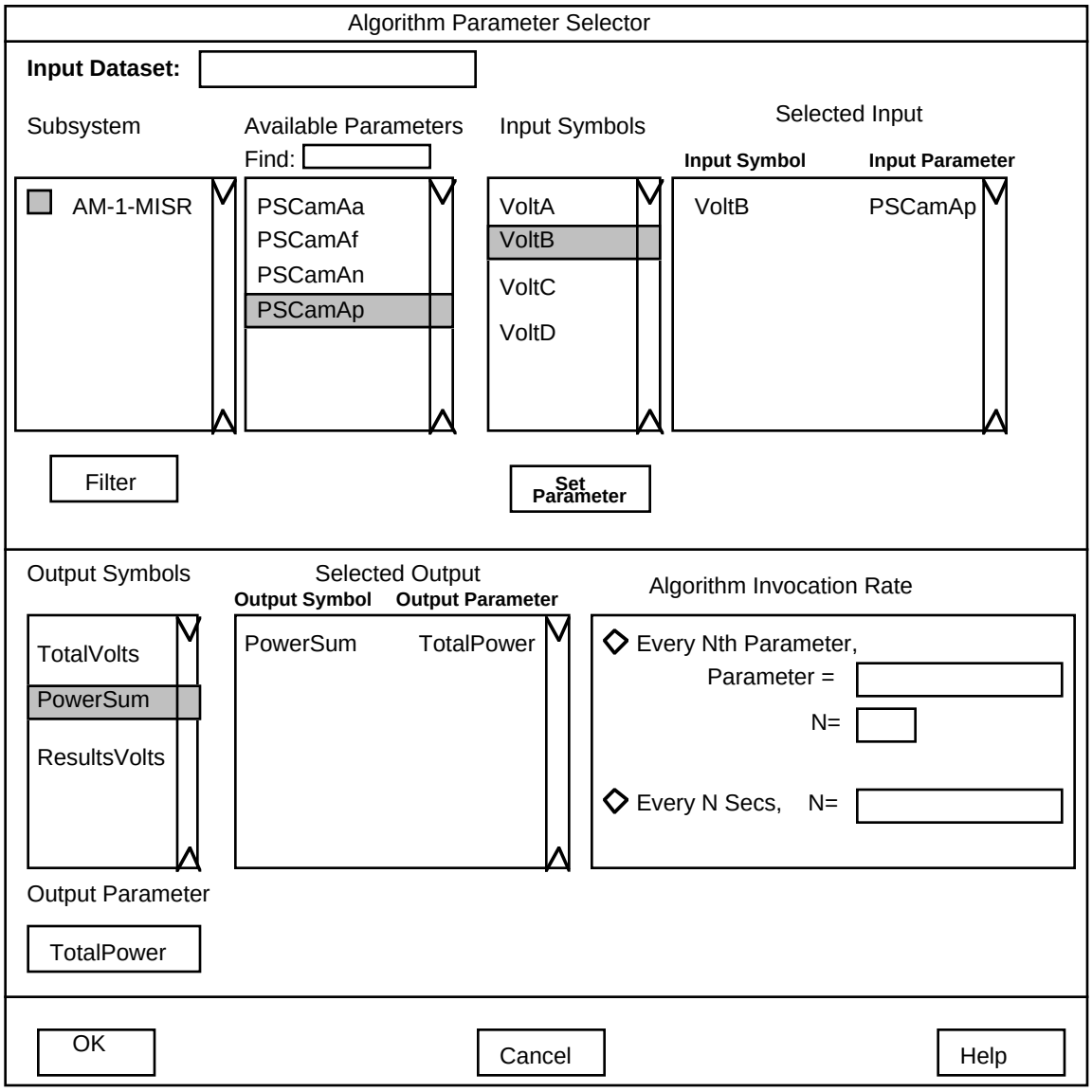

Figure 3.5-3. Algorithm Selector Window

3.5.4 Data Viewing and Manipulation

Data resulting from analysis can be viewed a number of ways previously described. See figures 3.5-4 and 3.5-5. Each plot an a graph may be subjected to numerical analysis of any of the following type: Curve fitting to a polynomial, along with extrapolation of parameter values, Fast Fourier Transforms, and data smoothing.

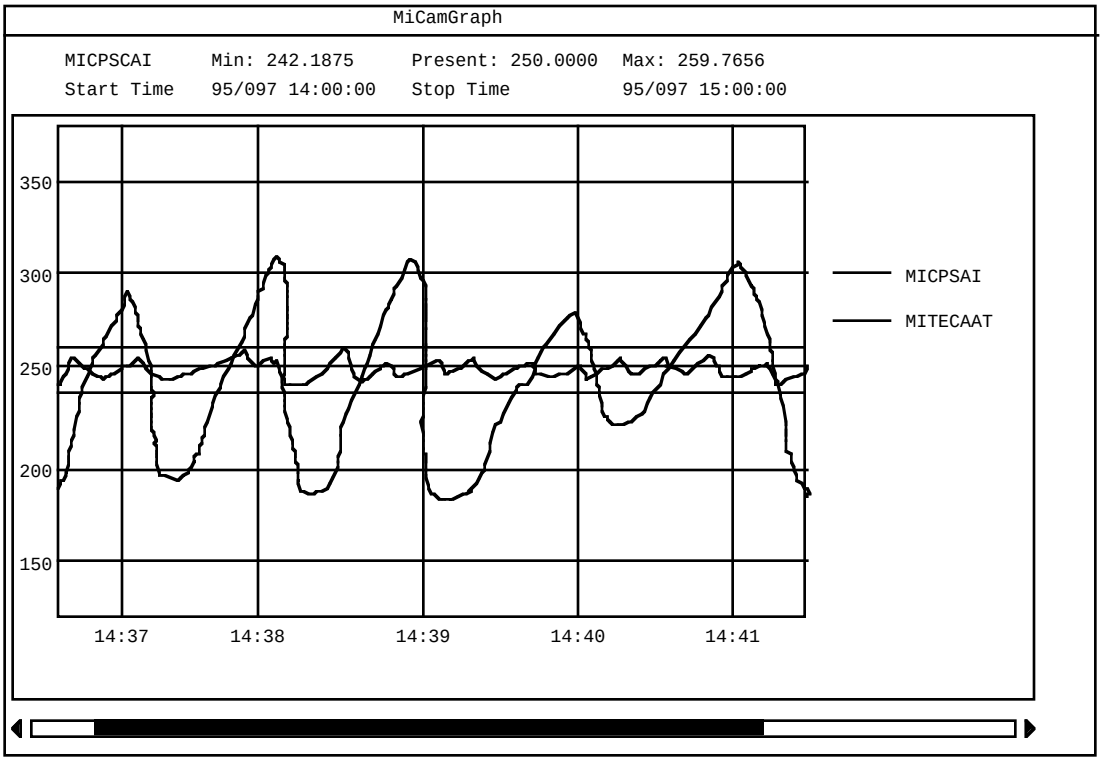

Figure 3.5-4. Example Plot

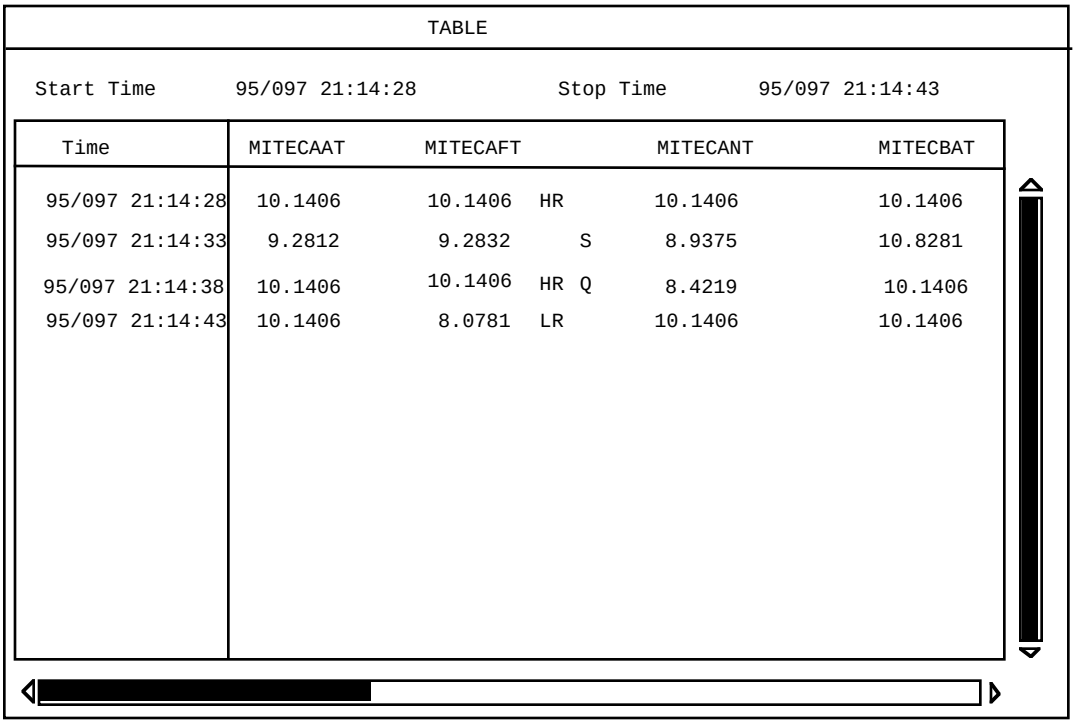

Figure 3.5-5. Example Table

3.5.5 Standing Orders

Certain analysis products are required on a regular basis in order to support routine operational duties. The IST allows the user to request the automatic generation of analysis requests or report requests at a specified time interval, such as hourly, daily, weekly, monthly, or by contact orbit. These automatic requests are called standing orders. The standing orders include the standing order manager and the standing order browser.

The standing order manager contains all the standing orders and will issue them at the specified time. The standing order manager is a background process that receives standing orders from the report template builder and the analysis history request builder. After processing the standing order, the standing order manager will send analysis requests to the analysis handler or report requests to the report generator at the specified time. After issuing a standing order, the standing order manager will receive the status and products from the analysis handler and the report generator.

The standing order browser contains a browser (Figure 3.5.5-1), a product viewer (Figure 3.5.5-2), and a modify dialog (Figure 3.5.5-3). The standing order browser allows users to view all the standing orders in the system. The user will be able to view the status of a standing order, as well as enable, disable, delete, and modify standing orders. The standing order product viewer allows users to view the completed standing order products, as well as products status, and sends the selected analysis product to the analysis product selector or the selected report to the report editor. The user is allowed to modify the standing order request name, activation time, ending time, and the standing order frequency by using the standing order modify dialog.

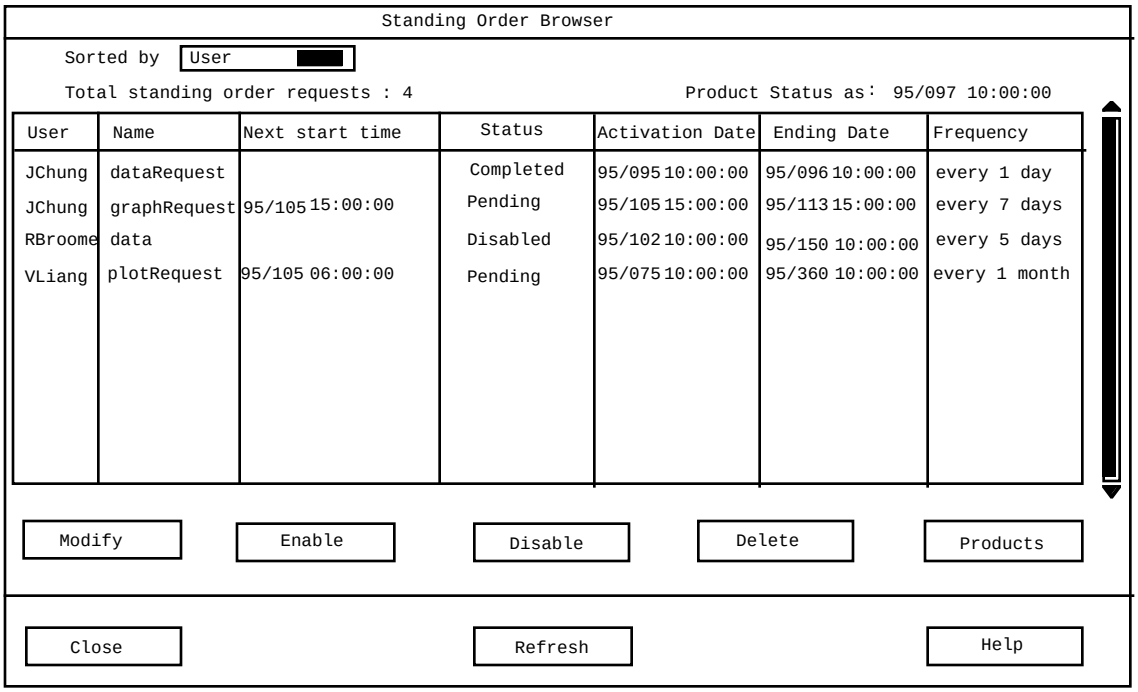

Figure 3.5.5-1. Standing Order Browser

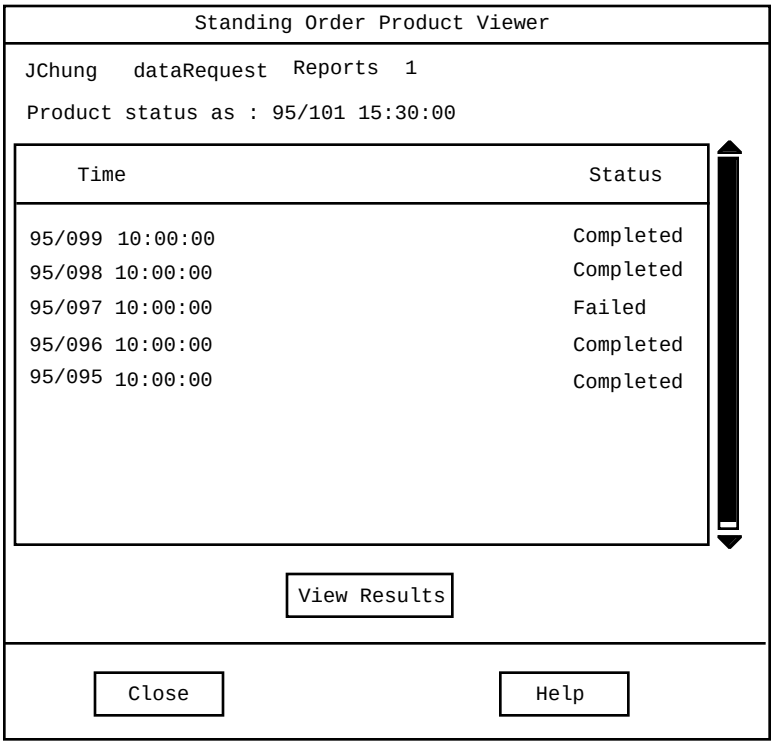

Figure 3.5.5-2. Standing Order Product Viewer

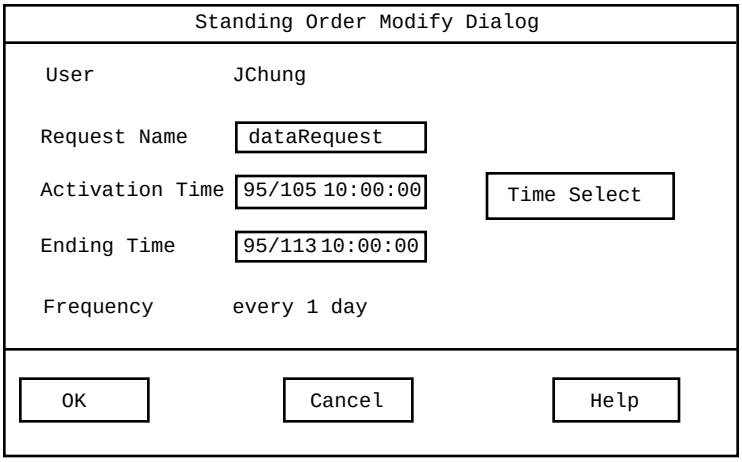

Figure 3.5.5-3. Standing Order Modify Dialog

3.5.6 Triggers

The user can define an analysis product to be automatically generated in response to a specific event, called a trigger. The user creates a request (using the same procedure defined above for requesting analysis) and defines an event that will trigger the output, such as an orbital event, or completion of a back-orbit telemetry merge.

3.6 Commanding

3.6.1 Procedure Builder

The IST allows a user to create, edit, store, delete, and print procedures. Each procedure contains a set of command language directives that perform a cohesive function (e.g., place an instrument in safe mode). Once a procedure has been created, an IST user can execute the procedure to perform local operations, such as setting up the workstation environment (e.g., display specific telemetry pages), or include the procedure in a command request that is sent to the FOT for execution. Only the Command Activity Controller (CAC) will be authorized to execute a procedure that contains spacecraft or instrument commands. An IST user performs procedure editing operations via a Procedure Builder tool. This tool consists of two windows: the Procedure Editor and the Command Builder. Each of these windows and its associated functionality is described below.

An IST user can invoke the Procedure Builder from the Tools menu, from any of several procedure selection dialogs, or via a command language directive. The Tools menu is accessed from the IST Control window. The procedure selection dialogs may be accessed from various other IST tools that are associated with procedures. Examples of such tools include the Command Monitor window, which allows an IST user to view the execution of the current ground script, and the Command Request window, which allows an IST user to create and submit command requests to the FOT. The command language directive that activates the Procedure Builder is entered via the command input line on the IST Control window.

When an IST user invokes the Procedure Builder, the Procedure Editor window (Figure 3.6.1-1) is displayed. This is the primary window used in the procedure editing process. The Procedure Editor window displays the contents of the procedure, provides the user typical editing operations, and performs syntax checking for all procedures. For command procedures the procedure editor can initiate command procedure validation.

When an IST user creates a new procedure, the Procedure Editor window displays a procedure template. The user fills in the header information, which includes the author's name, the creation date, the purpose of the procedure, and other pertinent information. The user then enters the appropriate command language directives. Once an IST user finishes editing a procedure, it may be saved under a user-supplied name, which should be representative of the function performed by the procedure. An IST user can also associate a specific spacecraft Id and instrument Id with each procedure when it is saved. When a procedure is saved, a user will also classify it according to a specific procedure type. These types include:

- Command - a procedure containing at least one spacecraft or instrument command directive.

- Emergency - a command procedure that performs an emergency operation. The FOT/IOT and the PI/TLs will establish the criteria for classifying emergency procedures.
- Ground - a procedure containing at least one ground system directive.
- Local - a procedure containing no command or ground system directives. This type of procedure is executed locally at the user's workstation.
- Activity - a procedure that will be associated with a Planning and Scheduling Activity definition.
- User-defined - a procedure may be saved as a user-defined type. User-defined types will be established by the FOT/IOT and PI/TLs.

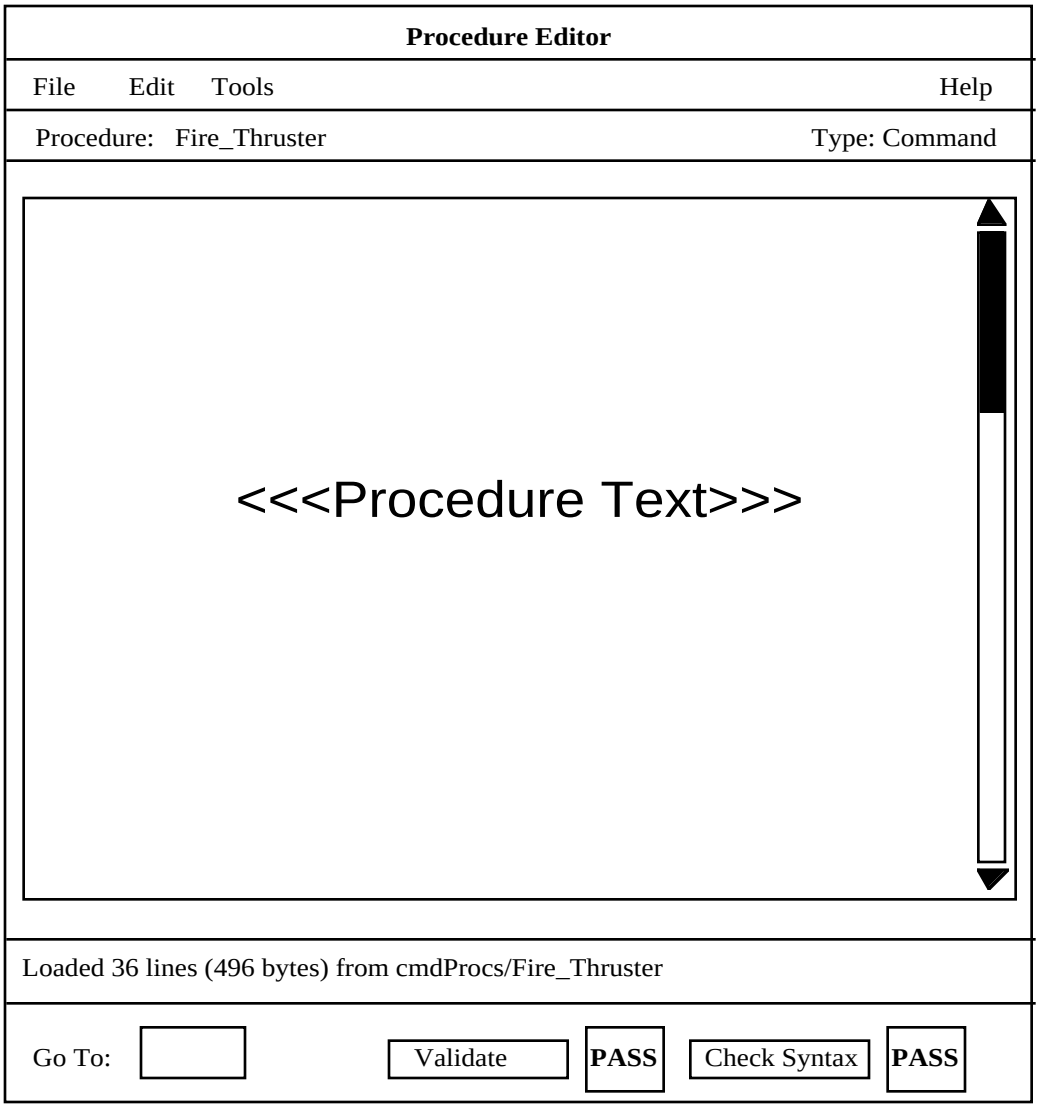

Figure 3.6.1-1. Procedure Editor

The save operation also maintains the current syntax check and validation status for each procedure. The Procedure Editor allows a user to perform a syntax check on the procedure directives. Errors are reported to the user and the syntax status is updated. Similarly, a user can request a validation check for command and emergency procedures. This check is performed by the Command Management Subsystem to determine if any command constraints are being violated. A user may save a procedure without performing a successful syntax and validation check. This allows a user to begin development of a procedure during one IST session and complete the procedure during a later session, perhaps the next day.

An IST user may also edit an existing procedure by specifying a procedure name when activating the Procedure Builder. The Procedure Editor displays the specified procedure in its text window. A user updates the change history in the procedure header and then makes the necessary modifications to the procedure directives. The Procedure Editor allows a user to perform typical text manipulation operations, such as cut, copy, paste, delete, and insert. The procedure is saved in the same manner described above for new procedures. A user may also save the procedure under a new name or different procedure type. The save operation verifies that the procedure directives are consistent with the specified procedure type (e.g., a local procedure cannot have any command directives).

An IST user may save a procedure to a local directory, where it is available for local use, or to a CM staging area, where it will undergo a CCB approval process (i.e., reviewed and tested). Once a procedure is approved by the CCB, it will be placed into an operational area where it may be accessed by all users. Command procedures must be approved by the CCB prior to being used by the FOT.

An IST user can also access the Command Request window from the Procedure Editor window. This allows a user to quickly create a procedure and associate it with a command request that is sent to the FOT.

The Command Builder window (Figures 3.6.1-2, 3.6.1-3), the second window that comprises the Procedure Builder, is activated from the Procedure Editor. This window allows an IST user to dynamically build directives and insert them into the procedure text. The Command Builder window contains scrolling lists of directive keywords, telemetry parameters, command mnemonics, and qualifiers, along with a palette of limit values.

The directive keyword list includes all of the valid ECL keywords that are used to construct a directive. When a user selects a keyword, the qualifier list displays the corresponding qualifiers associated with the keyword. For example, if a user selects the telemetry verification keyword, the qualifiers list will display the qualifiers ON and OFF. A user can insert any keyword or qualifier into the procedure text at the current cursor location.

The telemetry parameter list contains the valid telemetry mnemonics associated with a user-specified spacecraft or instrument. If a user selects a discrete parameter, the qualifier list displays the discrete states of the parameter. If a user selects an analog parameter, the limit values palette displays the current four limits values (high/low red, high/low yellow) for that parameter. A user can insert a mnemonic into the procedure text at the current cursor location. Similarly, a user can insert a symbolic constant representing any one of the four limit values into the procedure text. The symbolic constant will be replaced with the corresponding limit value when the procedure is executed.

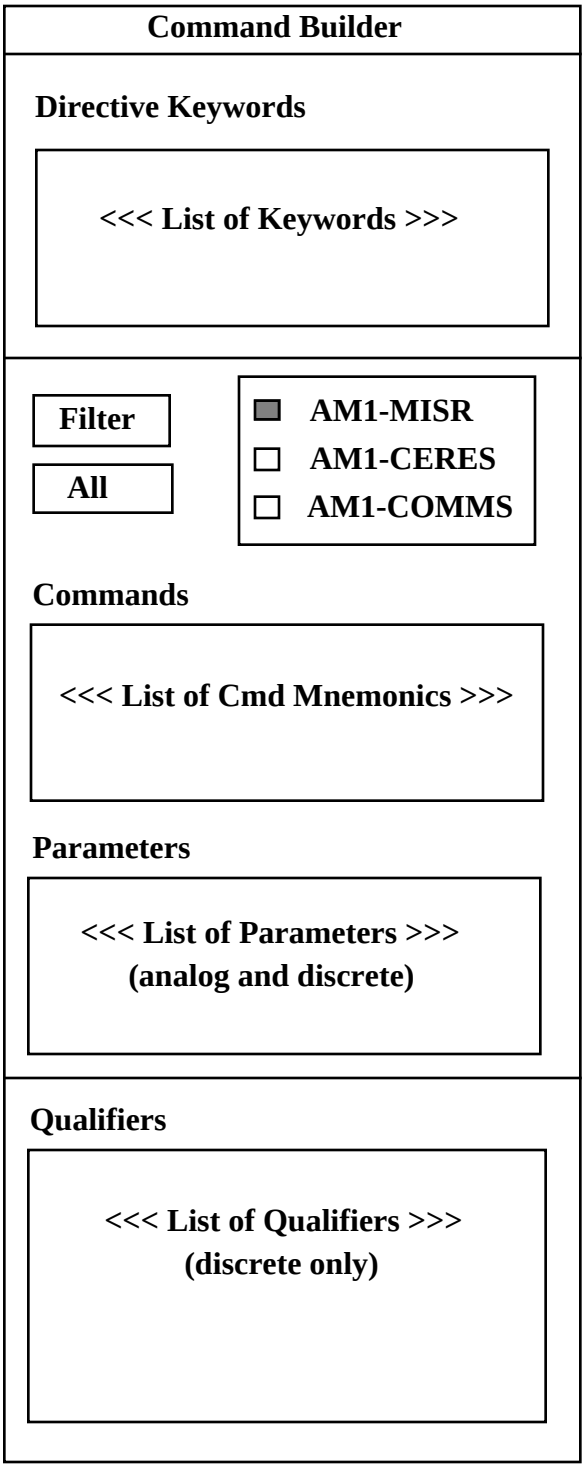

Figure 3.6.1-2. Command Builder (Qualifiers)

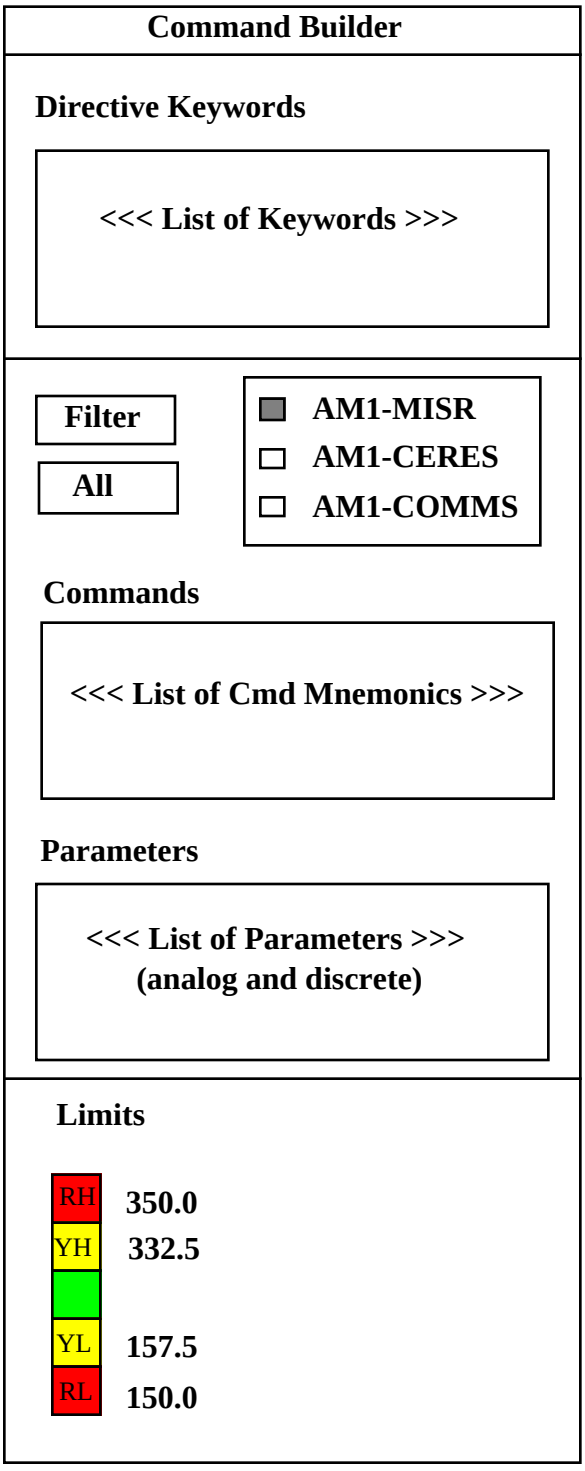

Figure 3.6.1-3. Command Builder (Limits)